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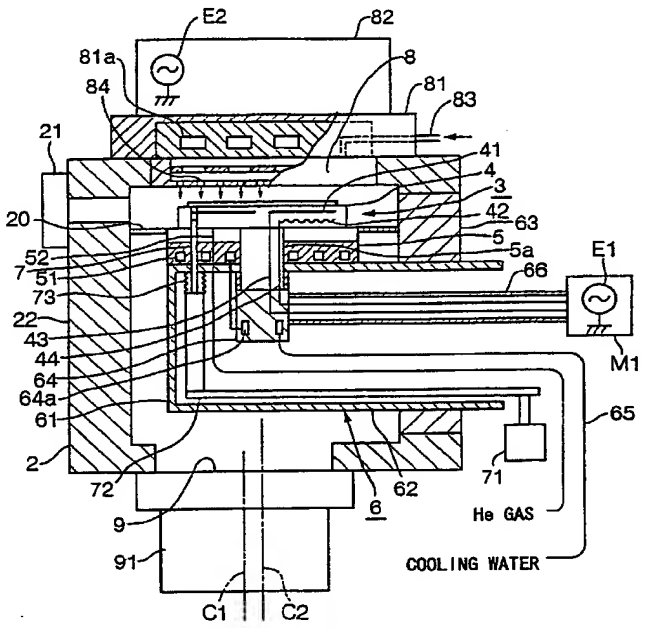
(54) Title: VACUUM PROCESSING APPARATUS



(57) Abstract: In a plasma CVD apparatus for applying a film deposition process to a semiconductor wafer (W), a wafer placement stage (3) is provided at a center of a vacuum chamber (2). The placement stage (3) is mounted to a side wall (63) via a support part (6). An exhaust port (9) having a diameter equal to or smaller than a diameter of the placement stage (3) is provided under the placement stage (3). A center axis (C1) of the exhaust port (9) is displaced from a center axis of the placement stage (3) in a direction opposite to an extending direction of the support part (6), thereby achieving an efficient exhaust.

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DESCRIPTION

VACUUM PROCESSING APPARATUS

TECHNICAL FIELD

The present invention relates to vacuum processing apparatuses and, more particularly, to a vacuum processing apparatus, which applies a film deposition process or the like to an object to be processed such as a semiconductor wafer under a vacuum.

BACKGROUND ART

There are plasma CVD (chemical vapor deposition) apparatuses for processing a semiconductor wafer (hereinafter referred to as "wafer"). Conventionally, a parallel plate type CVD apparatus is known as such kind of apparatus. In the parallel plate type CVD apparatus, a wafer placement stage constituting a lower electrode is positioned in the center of a vacuum chamber, and a gas supply part constituting an upper electrode is provided so as to face the placement stage. Plasma is generated by applying a voltage between the upper electrode and the lower electrode and the generated plasma is irradiated to the wafer so as to form a predetermined thin film on the wafer. The in-surface uniformity of the thin film formed on the wafer is greatly affected by an isotropy of the exhaust from the vacuum chamber. Accordingly, the exhaust port is provided directly under the placement stage so as to achieve the isotropy of the exhaust.

On the other hand, there is a technical demand for the plasma CVD apparatus to improve a gap fill characteristic. In order to improve the gap fill characteristic, a large flow and high-vacuum process is

needed, which cannot be achieved by a conventional apparatus. The reason for this is explained with reference to FIG. 1.

The plasma CVD apparatus shown in FIG. 1 comprises: a cylindrical vacuum chamber 11, a generally circular placement stage 12 that constitutes a lower electrode; a support part 14 for the placement stage 12; a gas supply part 13 that constitutes an upper electrode; an exhaust port 15; and a turbo-molecular pump 16. The semiconductor wafer W as an object to be processed is placed on the placement stage 12.

In recent years, a diameter of the placement stage 12 increases as a diameter of the semiconductor wafer increases. Accordingly, the placement stage 12 having a diameter equal to or larger than the diameter of the exhaust port 15 exists directly above the exhaust port 15. That is, when viewed from above the gas supply part 13, the exhaust port 15 is in a state in which the entire exhaust port 15 is covered by the placement stage 12. In such a structure, particles such as molecules of a gas moving within the vacuum chamber 11 cannot reach the exhaust port 15 by moving along a straight line. Thus, there is a problem in that exhaust efficiency is lowered.

DISCLOSURE OF INVENTION

It is a general object of the present invention to provide an improved and useful vacuum processing apparatus in which the above-mentioned problem is eliminated.

A more specific object of the present invention is to provide a vacuum processing apparatus which can achieve high exhaust efficiency and a high ultimate vacuum even for an object to be processed having a large diameter.

In order to achi ve the above-mentioned objects, there is provided according to one aspect of the present invention a vacuum processing apparatus for applying a predetermined process to an object to be processed which is placed on a substantially circular placement stage provided in a vacuum chamber by supplying a process gas to the vacuum chamber, characterized in that: the vacuum chamber has a substantially circular exhaust port under the placement stage, the exhaust port having a diameter equal to or smaller than a diameter of the placement stage; and a center axis of the exhaust port (9) is displaced from a center axis of the placement stage.

According to the present invention, since a part of the exhaust port protrudes from the placement stage when viewed from above the placement stage, a high-exhaust rate is achieved, and the ultimate vacuum is increased.

The vacuum processing apparatus according to the present invention may be provided with a support part so as to support the placement stage by extending from a side wall of the vacuum chamber toward the center of the vacuum chamber; and a direction of displacement of the center axis of the exhaust port with respect to the center axis of said placement stage is a direction opposite to an extending direction of the support part.

Since an area underneath the support part of the placement stage is covered by the support part, there is less effect of improvement in the exhaust efficiency if the exhaust port protrudes in such area. Accordingly, the exhaust efficiency can be improved at a maximum by having the exhaust port to protrude in a direction opposite to the extending direction of the support part of the placement table.

In the above-mentioned invention, the support

part may have a hollow structure, and a utility supply line may be provided therein. Additionally, the utility supply line may include at least one of a gas supply line, a cooling medium supply line and a power supply line. Further, the support part may be detachably attached to the vacuum chamber.

Additionally, in the above-mentioned invention, a baffle plate may be provided so as to surround the placement stage. The baffle plate preferably has many apertures, and an open area ratio on a side to which the exhaust port is displaced may be smaller than an open area ratio on the opposite side.

Additionally, in the above-mentioned invention, a displacement of the center axis of the exhaust port with respect to the center axis of the placement stage is preferably equal to or smaller than one eleventh of a diameter of the exhaust port. The exhaust port is preferably connected to a vacuum pump having a capacity to maintain the vacuum chamber at a pressure less than 10 Pa. The vacuum pump may be a turbo-molecular pump.

Additionally, in the above-mentioned invention, it is preferable that a gas supply part constituting a substantially circular showerhead is provided in the vacuum chamber, and a center axis of the showerhead is coincident with the center axis of the placement stage.

The placement stage and the gas supply part may be configured to apply a film deposition process to the object to be processed. Additionally, an upper electrode and a lower electrode may be provided so as to face to each other, wherein plasma of a process gas is generated between the upper electrode and the lower electrode so as to apply a film deposition process to the object to be processed by the generated plasma.

There is provided according to another aspect of the present invention a vacuum processing method for applying a predetermined process to an object to be processed in a vacuum chamber, the vacuum processing method comprising: placing the object to be processed at a position above an exhaust port of the vacuum chamber, a center of the object being horizontally displaced from a center of the exhaust port by a predetermined distance; and supplying a process gas to the object to be processed from a side opposite to the exhaust port with respect to the object to be processed and exhausting the process gas through the exhaust port so as to apply the predetermined process. The predetermined process may be a film deposition process.

Other objects, features and advantages of the present invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustration showing a structure of a conventional vacuum processing apparatus.

FIG. 2 is a cross-sectional view of a plasma CVD apparatus according to an embodiment of the present invention.

FIG. 3 is a perspective view of a vacuum chamber, a placement stage and a support part.

FIG. 4 is a plan view of an exhaust port and the placement stage.

FIG. 5 is a plan view of a baffle plate used in the plasma CVD apparatus shown in FIG. 2.

FIG. 6 is a graph showing a relationship between a displacement of a center axis of the exhaust port with

respect to a center axis of the placement stage.

BEST MODE FOR CARRYING OUT THE INVENTION

A description will now be given below, with reference to FIG. 2, of a vacuum processing apparatus according to an embodiment of the present invention. The vacuum processing apparatus according to the embodiment of the present invention shown in FIG. 2 is a plasma CVD apparatus, which applies a CVD process to a wafer as an object to be processed. The plasma CVD apparatus comprises a cylindrical vacuum chamber 2, which is made of aluminum. The vacuum chamber 2 is provided with a gate valve 21 so as to open and close a transportation port of a wafer W. A generally circular placement stage 3 is provided in an upper portion of the vacuum chamber 2 so as to place the wafer W, which is an object to be processed. The placement stage 3 is comprised of a generally circular placement part 4 and a generally circular base part (placement part support stage I) 5 having a diameter slightly larger than the diameter of the placement part 4.

A chuck electrode 41 constituting an electrostatic chuck is embedded in the vicinity of a surface of the placement part 4. Additionally, a heater 42 is embedded under the chuck electrode 41, which heater constitutes a temperature control unit for adjusting a temperature of the wafer W. The chuck electrode 41 also serves as a lower electrode for applying a high-frequency electric power. A cooling medium passage 51 is formed in the base part 5 so as to cool the base part 5 at a predetermined temperature by a cooling medium flowing through the cooling medium passage 51. Additionally, a helium gas supply passage 52 (indicated by a single line in the figure) is provided in the base part 5. Helium gas

is supplied to a small gap between the placement part 4 and the base part 5 through the helium gas supply passage 52 so as to control transfer of heat from the base part 5 to the placement part 4 by controlling the pressure of the helium gas. Thereby, the temperature of the wafer W is adjusted in cooperation with a control by the heater 42.

A description will now be given of a support structure of the placement stage 3 (the placement part 4 and the base part 5) in the vacuum chamber 2. The placement stage 3 is supported, as shown in FIG. 2, on a hollow cylindrical part 61 having a diameter approximately equal to the diameter of the base part 5. A hollow rectangular column part 62 is joined to a side of the cylindrical part 61, and an inner space of the cylindrical part 61 and an inner space of the rectangular column part 62 are communicated with each other. The rectangular column part 62 extends outside by passing through a side wall 63 of the vacuum chamber 2, and opens to the outside space of the vacuum chamber 2. That is, the inner space of the rectangular column part 62 communicates with the outside space of the vacuum chamber 2. The opening of the rectangular column part 62 may be closed by a lid member (not shown in the figure). The side wall 63 is joined to the rectangular column part 62, and the side wall 63 together with the rectangular column part 62 can be separated and removed from other side walls 22 of the vacuum chamber 2. In the structure shown in FIG. 2, a support part 6, which has a hollow structure and supports the placement stage 3, is constituted by the cylindrical part 61 and the rectangular column part 62.

The base part 5 is provided with a hole 5a in the center thereof, and a connecting part 64 is provided in the cylindrical part 61 so as to close the hole 5a. A

cooling medium passage 64a, which is connected to the cooling medium passage 51, is formed in the connecting part 64. Cooling water is supplied to the cooling medium passages 64a and 51 from a passage member 65 extending in the inner space of the support part 6, which passage member 65 is connected to an external cooling medium supply source (not shown in the figure) such as, for example, a cooling water supply source.

An end of a power supply line 43 is connected to the chuck electrode 41. The power supply line 43 extends through the connecting part 64, and enters an external matching box M1 via a hollow part of the rectangular column part 62 and connected to a high-frequency power source E1. The power supply line 43 is also connected to a direct current power source (not shown in the figure) for the electrostatic chuck. An insulating pipe 66 is provided between the connecting part 64 and the matching box M1, and the power supply line 43 extends through the insulating pipe 66. Additionally, an end of a power supply line 44 is connected to the heater 42, and the power supply source 44 extends through the connecting part 64 and enters the matching box M1 by passing through the insulating pipe 66. Further, the helium gas supply passage 52 also extends through the inner space of the support part 6 and is connected to an external gas supply source (not shown in the figure). In the example shown in FIG. 2, the gas supply passage 52, the passage member 65 and power supply lines 43 and 44 correspond to a utility supply line.

The placement stage 3 is provided with three lift pins 7, which are arranged along a circumference and penetrate the placement stage 3, so as to push up the wafer W. The lift pins 7 are vertically movabl by a

vertically moving mechanism 71 provided outside the support part 6 via a vertically moving member 72 provided in the support part 6. It should be noted that each of through holes in which the lift pins 7 are provided is sealed by a bellows 73. Additionally, a signal line of a sensor (not shown in the figure) for detecting a temperature of a back surface of the wafer W or the base part 5 is provided in the inner space of the support part 6. The signal line and a power supply line of the sensor also correspond the utility supply line.

A gas supply part 8 constituting a showerhead is provided to a ceiling of the vacuum chamber 2 so as to face the placement stage 3. A matching box 82 is mounted on the gas supply part 8 via a cooling part 81 in which a cooling medium passage 81a is formed. The gas supply part 8 is configured to eject a process gas, which is supplied through a gas supply pipe 83, toward the wafer W through many apertures 84. Additionally, the gas supply part 8 also serves as an upper electrode, and is connected to a high-frequency power source E2 in the matching box 82 and is insulated from the vacuum chamber 2.

A baffle plate 20 is provided between the outer surface of the placement stage 3 and the inner wall of the vacuum chamber 2. The baffle plate 20 has many apertures so that the open area ratio thereof is approximately 25%. An exhaust port 9 is formed on the bottom of the vacuum chamber 2, which exhaust port has a diameter approximately equal to or smaller than a diameter of the placement stage 3. The diameter of the placement stage 3 is a maximum diameter in the placement stage. That is, in the example shown in FIG. 2, the diameter of the placement stage 3 corresponds to the diameter of the base part 5, which is 288 mm, and the diameter of the exhaust port 9 is 270 mm.

A turbo-molecular pump 91 as a vacuum pump is conn cted to the exhaust port 9.

The center axis C1 of the exhaust port 9 is displaced from the center axis C2 of the placement stage 3. The direction of displacement is a direction opposite to the support part 6, that is, a reverse direction of a direction in which the support part 6 extends toward the side surface of the vacuum chamber 2. Additionally, the displacement D, which is a distance between the center axis C1 of the exhaust port 9 and the center axis C2 of the placement stage 3, is set to 15 mm. The method for setting the displacement D will be described later.

A description will now be given of an operation of the above-mentioned plasma CVD apparatus. First, the vacuum chamber 2 is evacuated until a predetermined vacuum is created. Thereafter, a wafer W is carried in the vacuum chamber 2 through the gate valve 21 by a transport arm (not shown in the figure), and the wafer W is placed on the placement stage 3. The placement of the wafer W on the placement stage 3 is performed by vertically moving the lift pins 7. Then, the vacuum chamber 2 is maintained at a predetermined vacuum, for example, 0.266 Pa to 0.399 Pa (2 mTorr to 3 mTorr) while supplying monosilane (SiH_4) gas, which is a process gas, and oxygen (O_2) gas from the gas supply part 42 to the vacuum chamber 2 at predetermined flow rates, respectively. Then, high-frequency power of 2 MHz, 1 kW and 16 MHz, 3 kW is applied to the lower electrode (placement stage) 3 and the upper electrode (gas supply part) 8 by the high-frequency power sources E1 and E2, respectively. Thereby, a high-frequency electric field is generated between the lower electrode 3 and the upper electrode 8 so as to generated plasma of the process gas by the energy of the high

frequency wave. Then, a silicon oxidation film is formed on the wafer W by irradiating the generated plasma onto the wafer W.

According to the above-mentioned embodiment, the center axis C1 of the exhaust port 9 is displaced from the center axis C2 of the placement stage 3 in a direction opposite to the support part 6, and, thereby, when viewed from above the exhaust port 9 (that is, when viewed from a side of the gas supply part 8 constituting the showerhead), there is a part in which the placement stage 3 and the support part 6 do not overlap the exhaust port 9. Accordingly, as indicated by a hatched semilunar part in FIG. 4, the part of the exhaust port 9 protrudes from a projected area of the placement stage 3 and the support part 6. Thus, particles such as gas molecules moving in the vacuum chamber 2 can reach the exhaust port 9 by moving along a straight line. Thereby, the probability of particles entering the exhaust port 9 is increased, which achieves high exhaust efficiency. Thereby, when the diameter of the wafer W is increased, the vacuum chamber 2 can be evacuated with high exhaust efficiency by using a small pump as the turbo-molecular pump 91 such as, for example, a turbo-molecular pump having an exhaust rate of 1800 liters/second. Additionally, the ultimate vacuum is increased, and a film deposition process with a good gap fill characteristic can be performed.

Further, since the support part 6 can be removed together with the placement stage 3 from the vacuum chamber 2, a maintenance operation with respect to the placement stage 3 is facilitated. Additionally, since the support part 6 has a hollow structure, a maintenance operation related to the utility can be performed without removing the support part 6 from the vacuum chamber 2.

Thus, the vacuum processing apparatus according to th present embodiment can provide an easy maintenance operation.

Additionally, since the vacuum processing apparatus according to the present embodiment is provided with the baffle plate 20, evacuation of gas can be performed with high isotropy. That is, the baffle plate 20 has a function to compensate for a deflection of exhaust caused by the displacement of the exhaust port 9 with respect to the placement stage 3. Although the open area ratio of the baffle plate 20 in this embodiment is approximately 25% as the entire baffle plate, the open area ratio of an area above a part of the exhaust port 9 protruding from the placement stage 3 is locally smaller than the open area ratio of other parts of the baffle plate 20. Thereby, the deflection of exhaust caused by the displacement of the exhaust port 9 with respect to the placement table 3 is compensated for.

FIG. 5 is a plan view of the baffle plate 20 used in the present embodiment. As shown in FIG. 5, many slits 20a are formed in the baffle plate 20 by being arranged in a circumferential direction, and a pitch P of the slits 20a is larger on the side of the exhaust port 9 protruding from the placement stage 3 and is smaller on the opposite side. Additionally, the width A of each of the slits 20a is smaller on the protruding side, and is larger on the opposite side. Thereby, the open area ratio of the baffle plate is locally changed. The configuration of changing the open area ratio is not limited to the above-mentioned structure, and, for example, a length of each of the slits 20a may be changed. It should be noted that there is no need to always provide the baffle plate 20 if the deflection of exhaust is in a negligible degree.

In the structure of the present embodiment, the displacement of the exhaust port 9 with respect to the placement stage 3 has a reverse action that the exhaust rate is reduced. That is, when the exhaust port 9 is displaced from the placement stage 3, there is an area that is located deep inside the projected area of the placement stage 3. If the displacement D is large, a degree of decrease in the exhaust efficiency due to the area inside the projected area of the placement stage 3 may become greater than a degree of increase in the exhaust efficiency due to the area protruding from the projected area of the placement stage 3. The exhaust rate in such as case becomes smaller than that when the exhaust port 9 is not displaced. Accordingly, the displacement D must be determined in consideration with this point.

Additionally, if a large displacement is provided to the exhaust port 9 and the isotropy of exhaust is maintained by the baffle plate 20, the conductance (resistivity) provided by the baffle plate 20 is increased, which causes a decrease in the exhaust efficiency (exhaust rate) as a whole.

FIG. 6 is a graph showing a result of investigation of a relationship between an effective exhaust rate and the displacement D of the center axis C1 of the exhaust port 9 with respect to the center axis C2 of the placement stage 3. When the displacement D was increased, the exhaust rate was also increased and maximized at about 15 mm. When the displacement D exceeded approximately 15 mm, the exhaust rate was decreased and became smaller than that when the exhaust port 9 was not displaced when the displacement was at approximately 25 mm. That is, the effective exhaust rate was at a maximum when the displacement D was approximately

15 mm, and the exhaust rate was increased when th displacement D is less smaller than approximately 25 mm. The diameter of the export port 9 was 270 mm, and it was found that the displacement D is preferably less than one eleventh of the diameter of the exhaust port 9. The present invention is based on the above-mentioned findings, and the vacuum processing apparatus according to the present invention can achieve high efficiency exhaust since the displacement D is set to 15 mm.

Additionally, the present invention is especially effective in a case in which a gas flow in the vacuum chamber 2 is in the middle between a viscous flow and a molecular flow or in the range of the molecular flow. Accordingly, for example, the present invention is suitable for a case in which a process is performed under a pressure lower than 10 Pa.

In the above-mentioned embodiment, the vacuum pump is not limited to the turbo-molecular pump. Additionally, as for the process performed under a vacuum, there is an etching process, a sputtering process or an ashing process.

The present invention is not limited the specifically disclosed embodiments, and variations and modifications may be made without departing form the scope of the present invention.

CLAIM

1. A vacuum processing apparatus for applying a predetermined process to an object (W) to be processed which is placed on a substantially circular placement stage (3) provided in a vacuum chamber (2) by supplying a process gas to the vacuum chamber (2),

characterized in that:

said vacuum chamber (2) has a substantially circular exhaust port (9) under said placement stage (3), the exhaust port having a diameter equal to or smaller than a diameter of said placement stage (3); and

a center axis (C1) of said exhaust port (9) is displaced from a center axis (C2) of said placement stage (3).

2. The vacuum processing apparatus as claimed in claim 1, characterized in that:;

a support part (6) is provided so as to support said placement stage (3) by extending from a side wall (63) of said vacuum chamber (2) toward the center of said vacuum chamber (2); and

a direction of displacement of the center axis (C1) of said exhaust port (9) with respect to the center axis (C2) of said placement stage (3) is a direction opposite to an extending direction of said support part (6).

3. The vacuum processing apparatus as claimed in claim 2, characterized in that said support part (6) has a hollow structure, and a utility supply line is provided therein.

4. The vacuum processing apparatus as claimed in claim 3, characterized in that said utility supply lin includes at least one of a gas supply line (52), a cooling medium supply line (65) and a power supply line (43, 44).

5. The vacuum processing apparatus as claimed in claim 3, characterized in that said support part (6) is detachably attached to said vacuum chamber (2).

6. The vacuum processing apparatus as claimed in one of claims 1 to 5, characterized in that a baffle plate (20) is provided so as to surround said placement stage (3).

7. The vacuum processing apparatus as claimed in claim 6, characterized in that said baffle plate (20) has many apertures (20a), and an open area ratio on a side to which said exhaust port (9) is displaced is smaller than an open area ratio on the opposite side.

8. The vacuum processing apparatus as claimed in one of claims 1 to 5, characterized in that a displacement (D) of the center axis (C1) of said exhaust port (9) with respect to the center axis (C2) of said placement stage (3) is equal to or smaller than one eleventh of a diameter of said exhaust port (9).

9. The vacuum processing apparatus as claimed in one of claims 1 to 5, characterized in that said exhaust port (9) is connected to a vacuum pump (91) having a capacity to maintain said vacuum chamber (2) at a pressure less than 10 Pa.

10. The vacuum processing apparatus as claimed in claim 9, characterized in that said vacuum pump is a turbo-molecular pump (91).

11. The vacuum processing apparatus as claimed in one of claims 1 to 5, characterized in that a gas supply part (8) constituting a substantially circular showerhead is provided in said vacuum chamber (2), and a center axis of said showerhead is coincident with the center axis (C2) of said placement stage (3).

12. The vacuum processing apparatus as claimed in claim 11, characterized in that said placement stage (3) and said gas supply part (8) are configured to apply a film deposition process to said object (W) to be processed.

13. The vacuum processing apparatus as claimed in one of claims 1 to 5, characterized in that an upper electrode (8) and a lower electrode (41) are provided so as to face to each other, wherein plasma of a process gas is generated between said upper electrode (8) and said lower electrode (41) so as to apply a film deposition process to said object (W) to be processed by the generated plasma.

14. A vacuum processing method for applying a predetermined process to an object (W) to be processed in a vacuum chamber (2), the vacuum processing method comprising:

placing said object (W) to be processed at a position above an exhaust port (9) of said vacuum chamber (2), a center of said obj ct (W) being horizontally displaced from a center of said exhaust port (9) by a

predetermined distance; and

supplying a process gas to said object (W) to be processed from a side opposite to said exhaust port (9) with respect to said object (W) to be processed and exhausting the process gas through said exhaust port (9) so as to apply said predetermined process.

15. The vacuum processing method as claimed in claim 14, characterized in that said predetermined process is a film deposition process.

FIG. 1

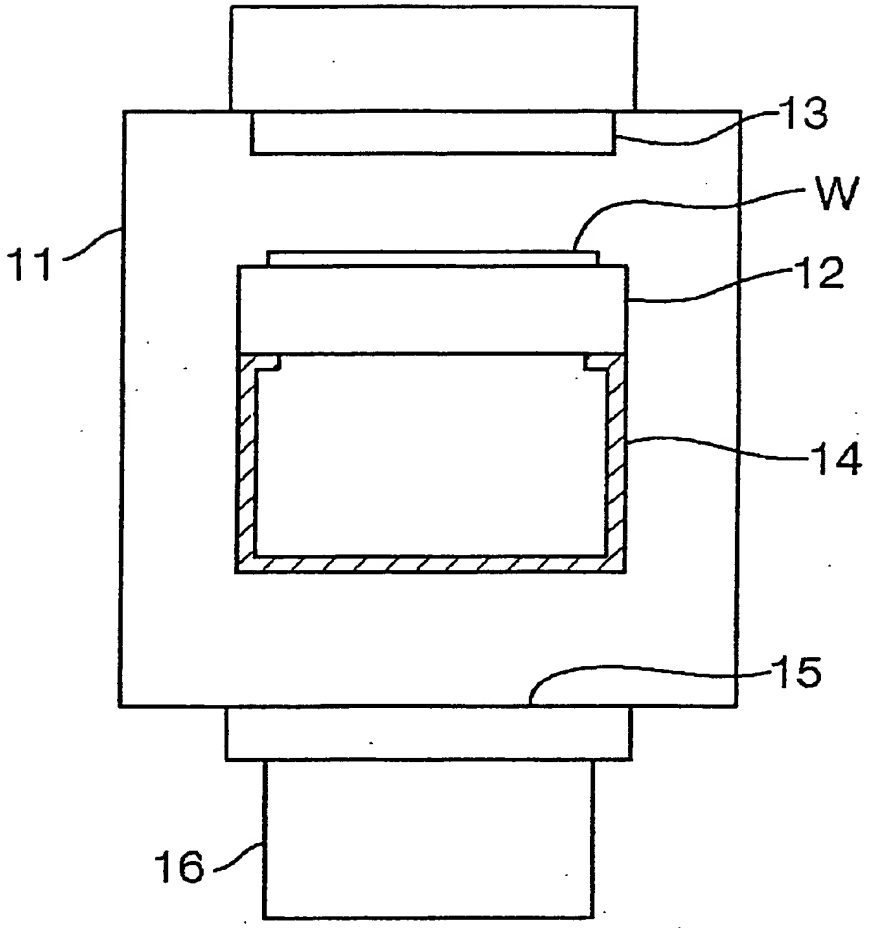
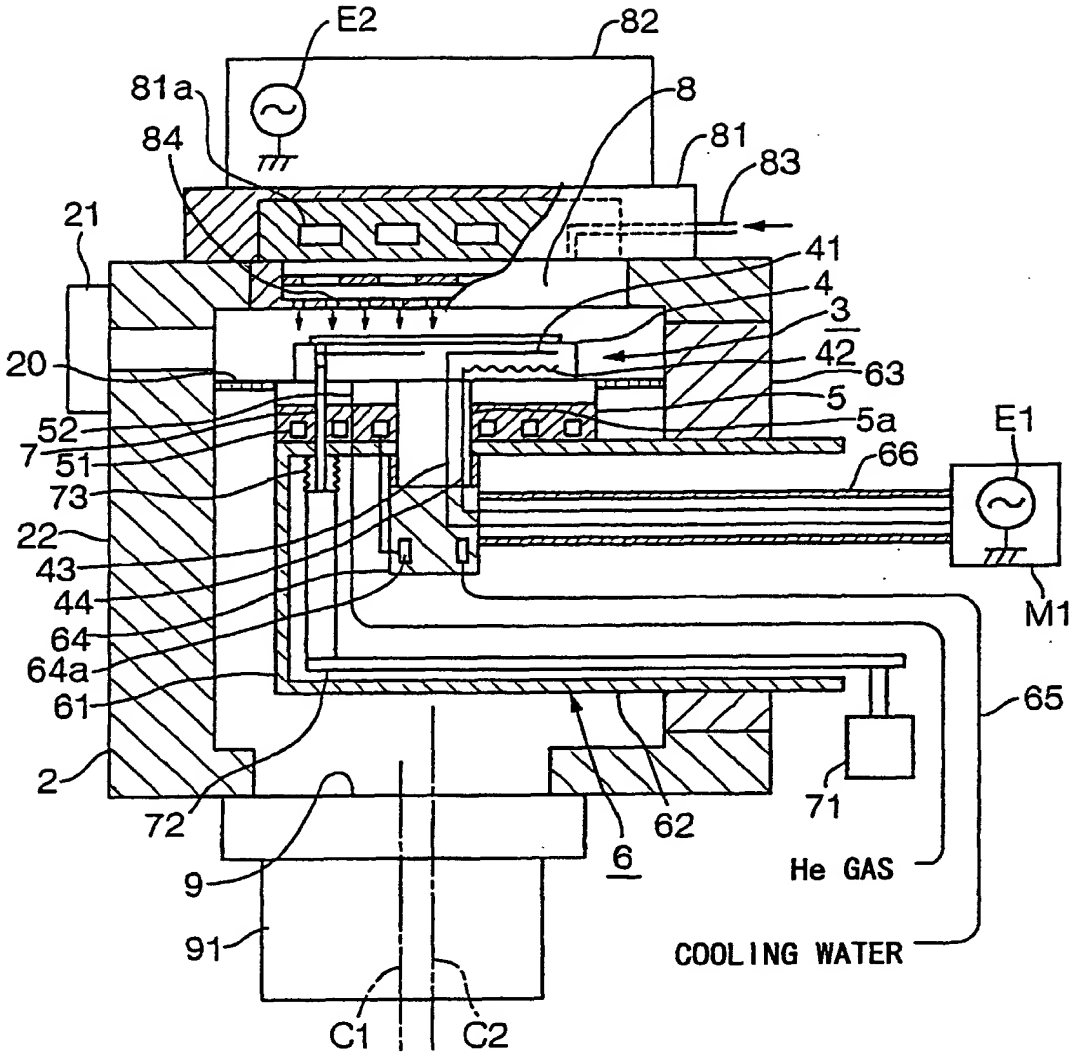


FIG. 2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COOLING WATER

FIG. 3

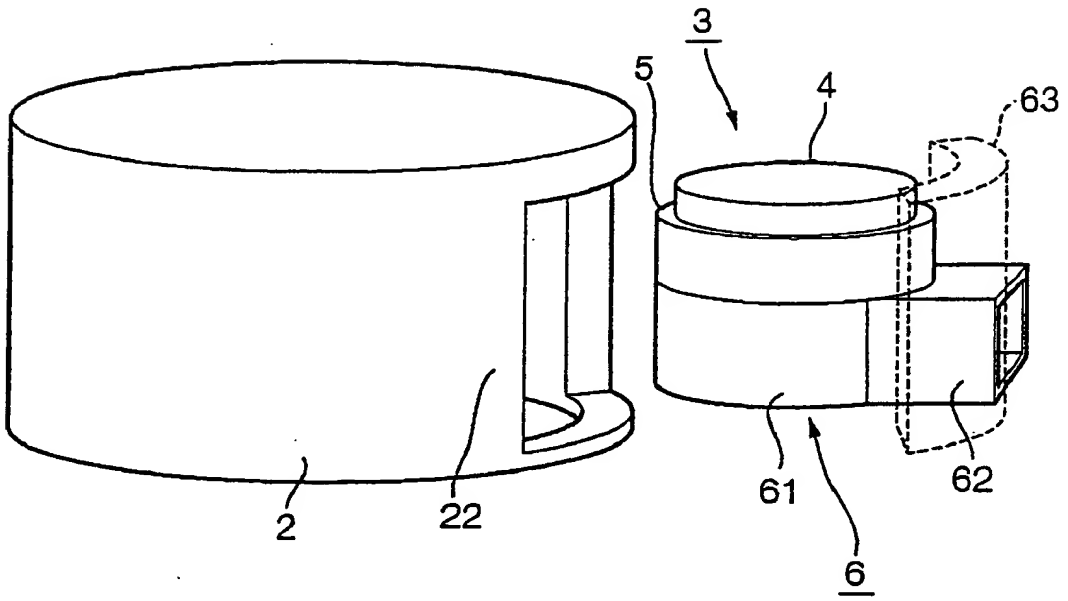


FIG. 4

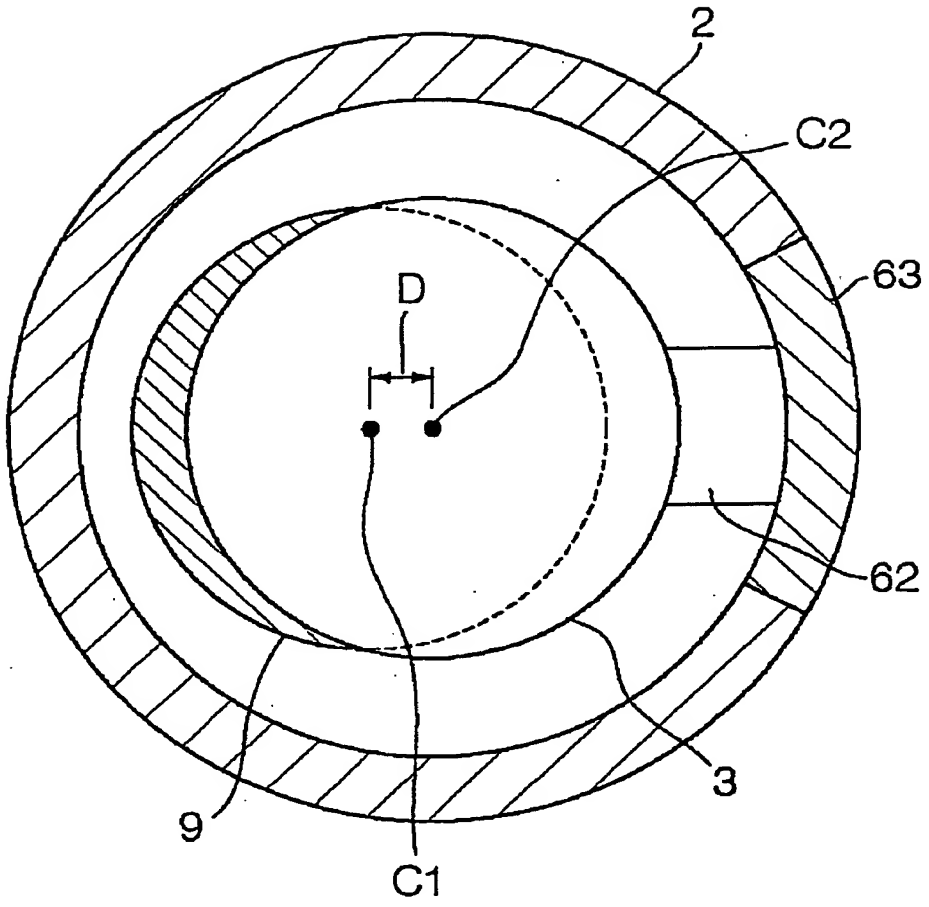


FIG.5

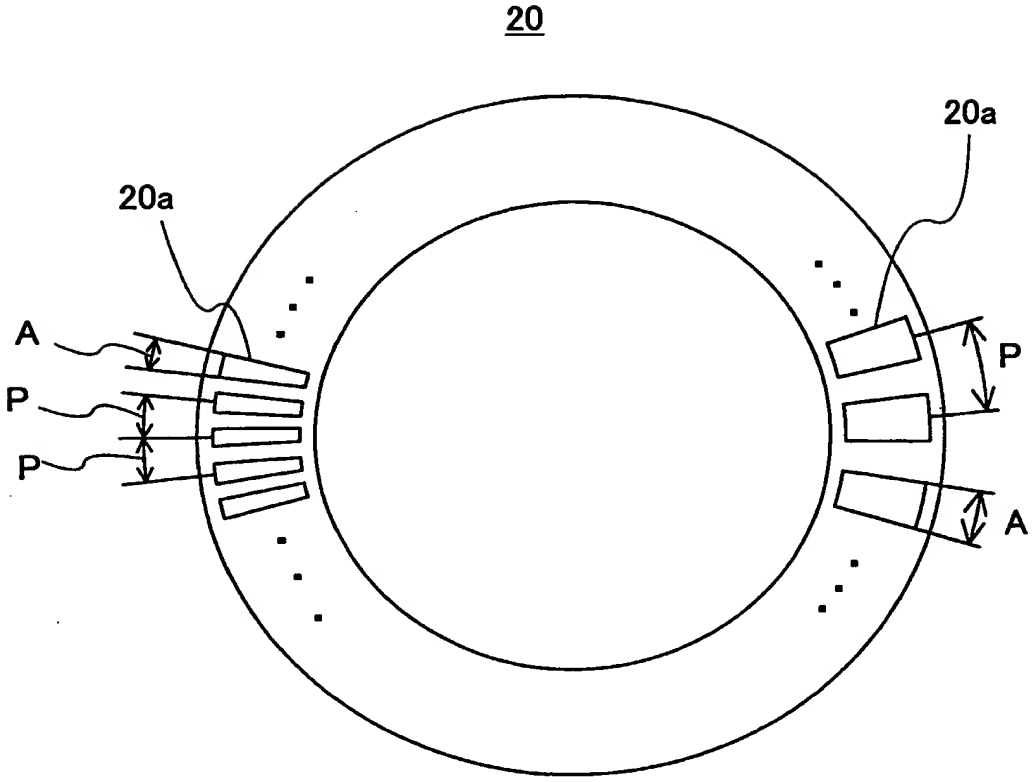
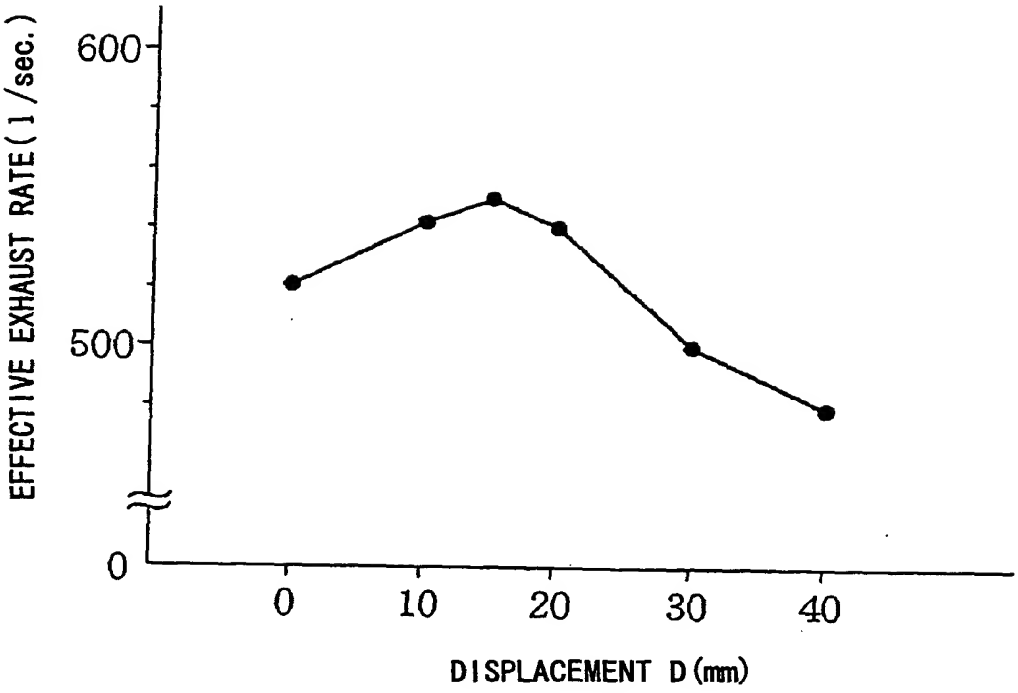


FIG. 6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DISPLACEMENT D(mm)

INTERNATIONAL SEARCH REPORT

Inter[redacted]ial Application No
PCT[redacted] 01/00081

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C23C16/44 H01L21/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C23C H01L C30B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, WPI Data, IBM-TDB, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5 552 017 A (YU CHEN-HUA ET AL) 3 September 1996 (1996-09-03) column 4, line 50 -column 5, line 34; figure 2	1,9-15 2-7
Y	EP 0 819 780 A (APPLIED MATERIALS INC) 21 January 1998 (1998-01-21) column 8, line 53 -column 17, line 7 column 4, line 19 - line 50	2-5
Y	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 14, 22 December 1999 (1999-12-22) -& JP 11 243079 A (TOSHIBA CORP;IWATE TOSHIBA ELECTRONICS KK), 7 September 1999 (1999-09-07) abstract	6,7

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 April 2001	11/04/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Ekhult, H

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PC[redacted] 01/00081

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 5552017	A	03-09-1996	NONE		
EP 0819780	A	21-01-1998	US	6170428 B	09-01-2001
			JP	10116826 A	06-05-1998
			US	6182602 B	06-02-2001
JP 11243079	A	07-09-1999	NONE		

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
EL00023PCT		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/JP 01/00081	11/01/2001	12/01/2000
Applicant		
TOKYO ELECTRON LIMITED		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 2

   [ ] as suggested by the applicant.

   [X] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PCT 01/00081

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C23C16/44 H01L21/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C23C H01L C30B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, WPI Data, IBM-TDB, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5 552 017 A (YU CHEN-HUA ET AL) 3 September 1996 (1996-09-03) column 4, line 50 -column 5, line 34; figure 2	1,9-15 2-7
Y	EP 0 819 780 A (APPLIED MATERIALS INC) 21 January 1998 (1998-01-21) column 8, line 53 -column 17, line 7 column 4, line 19 - line 50	2-5
Y	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 14, 22 December 1999 (1999-12-22) -& JP 11 243079 A (TOSHIBA CORP;IWATE TOSHIBA ELECTRONICS KK), 7 September 1999 (1999-09-07) abstract	6,7

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 April 2001	11/04/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Ekhult, H

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PC[redacted] 01/00081

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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EP 0819780 A	21-01-1998	US 6170428 B	09-01-2001
		JP 10116826 A	06-05-1998
		US 6182602 B	06-02-2001
JP 11243079 A	07-09-1999	NONE	

09/890833

PCT REQUEST

EL00023PCT

Original (for **SUBMISSION**) - printed on 10.01.2001 10:15:48 AM

0	**For receiving Office use only**	
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	

0-4	**Form - PCT/RO/101 PCT Request**	
0-4-1	Prepared using	PCT-EASY Version 2.91 (updated 01.01.2001)
0-5	**Petition**	
	The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	Japanese Patent Office (RO/JP)
0-7	**Applicant's or agent's file reference**	EL00023PCT
I	**Title of invention**	VACUUM PROCESSING APPARATUS
II	**Applicant**	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	TOKYO ELECTRON LIMITED
II-5	Address:	3-6, Akasaka 5-Chome, Minato-Ku, Tokyo 107-8481 Japan
II-6	State of nationality	JP
II-7	State of residence	JP
III-1	**Applicant and/or inventor**	
III-1-1	This person is:	applicant and inventor
III-1-2	Applicant for	US only
III-1-4	Name (LAST, First)	AMANO, Hideaki
III-1-5	Address:	c/o TOKYO ELECTRON LIMITED, 2-30-7, Sumiyoshi-Cho, Fuchu-Shi, Tokyo 183-8705 Japan
III-1-6	State of nationality	JP
III-1-7	State of residence	JP

PCT REQUEST

EL00023PCT

Original (for **SUBMISSION**) - printed on 10.01.2001 10:15:48 AM

IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name (LAST, First)	ITOH, Tadahiko
IV-1-2	Address:	32nd Floor, Yebisu Garden Place Tower, 20-3, Ebisu 4-chome, Shibuya-ku, Tokyo 150-6032 Japan
IV-1-3	Telephone No.	03-5424-2511
IV-1-4	Facsimile No.	03-5424-2525
V	**Designation of States**	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT (except TR)
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	JP KR US
V-5	**Precautionary Designation Statement** In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
V-6	**Exclusion(s) from precautionary designations**	NONE
VI-1	**Priority claim of earlier national application**	
VI-1-1	Filing date	12 January 2000 (12.01.2000)
VI-1-2	Number	Patent Application 2000-003337
VI-1-3	Country	JP
VII-1	**International Searching Authority Chosen**	European Patent Office (EPO) (ISA/EP)

PCT REQUEST EL00023PCT

Original (for **SUBMISSION**) - printed on 10.01.2001 10:15:48 AM

VIII	Check list	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	14	-
VIII-3	Claims	4	-
VIII-4	Abstract	1	EZABST00.TXT
VIII-5	Drawings	6	-
VIII-7	TOTAL	29	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-9	Separate signed power of attorney	✓	-
VIII-10	Copy of general power of attorney	✓	-
VIII-12	Priority document(s)	Item(s) VI-1	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-17	Other (specified):	Revenue stamps of transmittal fee for receiving office	-
VIII-17	Other (specified):	Submission of certificate of payment for search fee	-
VIII-17	Other (specified):	Submission of certificate of payment for international fee	-
VIII-18	**Figure of the drawings which should accompany the abstract**		
VIII-19	**Language of filing of the international application**	English	
IX-1	**Signature of applicant or agent**		
IX-1-1	Name (LAST, First)	ITOH, Tadahiko	

FOR RECEIVING OFFICE USE ONLY

10-1	**Date of actual receipt of the purported international application**	
10-2	**Drawings:**	
10-2-1	Received	
10-2-2	Not received	
10-3	**Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application**	
10-4	**Date of timely receipt of the required corrections under PCT Article 11(2)**	
10-5	**International Searching Authority**	ISA/EP

PCT REQUEST

EL00023PCT

Original (for **SUBMISSION**) - printed on 10.01.2001 10:15:48 AM

10-6	**Transmittal of search copy delayed until search fee is paid**	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	**Date of receipt of the record copy by the International Bureau**	

APPLICATION UNDER UNITED STATES PATENT LAWS

Atty. Dkt. No. PW 282726
(M#)

Invention: VACUUM PROCESSING APPARATUS

Inventor (s): AMANO, Hideaki

Pillsbury Winthrop LLP
Intellectual Property Group
101 W. Broadway, Suite 1800
San Diego, CA 92101-8219
Attorneys
Telephone: (619) 234-5000

This is a:

- ☐ Provisional Application
- ☐ Regular Utility Application
- ☐ Continuing Application
  - ☒ The contents of the parent are incorporated by reference
- ☒ PCT National Phase Application
- ☐ Design Application
- ☐ Reissue Application
- ☐ Plant Application
- ☐ Substitute Specification
  Sub. Spec Filed _____
  in App. No. _____ /
- ☐ Marked up Specification re
  Sub. Spec. filed _____
  In App. No _____ /

SPECIFICATION

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

ITOH, Tadahiko
32nd Floor, Yebisu Garden Place Tower
20-3, Ebisu 4-chome
Shibuya-ku, Tokyo 150-6032
JAPON

Date of mailing (day/month/year) 14 February 2001 (14.02.01)	
Applicant's or agent's file reference EL00023PCT	**IMPORTANT NOTIFICATION**
International application No. PCT/JP01/00081	International filing date (day/month/year) 11 January 2001 (11.01.01)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 12 January 2000 (12.01.00)
Applicant TOKYO ELECTRON LIMITED et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.

3. An **asterisk(*)** appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

4. The **letters "NR"** appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
12 Janu 2000 (12.01.00)	2000/3337	JP	29 Janu 2001 (29.01.01)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer

Susumu Kubo

Telephone No. (41-22) 338.83.38